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EXAMINER

PAREKH, NITIN

ART UNIT PAPER NUMBER

2811

DATE MAILED: 11/20/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

09/517,345

Applicant(s)

ANDERSON ET AL.

Examiner

Nitin Parekh

Art Unit

2811

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 29 September 2003.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-25 and 49-70 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-25 and 49-70 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. §§ 119 and 120**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 13) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.
- a) ☐ The translation of the foreign language provisional application has been received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_

## DETAILED ACTION

### ***R equest for Continued Examination***

1. A request for continued examination (RCE) under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 07/11/03 and 09/29/03 have been entered. An action on the RCE follows.

### ***Drawings***

2. The drawings are objected to by the PTO Draftsperson for the reasons noted on the attached Notice of Draftsperson's Patent Drawing Review, form PTO-948.
3. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims.

The limitations as recited in claim 17, line 2, include "the cross-sectional area of the silicon die is larger than the cross-sectional area of the transition medium".

Therefore, the comparison/differences of the cross-sectional areas indicating larger area of the die with respect to that of the transition medium must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

***Claim Rejections - 35 USC § 103***

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 20 and 22-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schueller (US Pat. 5866949).

Regarding claim 20, Schueller discloses an integrated circuit (IC)/BGA package comprising:

- a metallized polymer layer (MPL)/flexible dielectric tape (FDT) substrate (59/60 in Fig. 3B/3A; Col. 7, lines 30-35) having a first/top side and a second/bottom side, the MPL/FDT defining a first thickness
- a transition medium/support structure (50 in Fig. 3B/3A) coupled to the MPL/FDT
- a silicon die (52 in Fig. 3B/3A) coupled to the transition medium

- a conventional plastic encapsulant/mold cap encapsulating the transition medium and the die (mold cap not numerically referenced- see Fig. 3B; Col. 8, line 40), the mold cap defining a second thickness, wherein the first and second thickness define a package thickness, and
- the die being disposed approximately in the middle of the package thickness measured from the bottom of the MPL/FDT to the top of the mold cap (see Fig. 3B)

(Fig. 3B/3A; Col. 8, line 12- Col. 10, line 36; Col. 5, line 36- Col. 6, line 55).

Schueller fails to explicitly teach the die being disposed near a midline of the package.

The determination of parameters such as a thickness of a substrate/metallized polymer, plastic encapsulant/mold, finished package including the die, substrate and the encapsulant, thickness/area/volume ratio of various components, relative position and an arrangement of various components within the package, etc. in the chip packaging and encapsulation technology art is a subject of routine experimentation and optimization to achieve the desired thermal, dimensional/mechanical and electrical/reliability requirements including weight/size, rigidity/strength and stress distribution.

It would have been obvious to a person of ordinary skill in the art at the time invention was made to incorporate the die being disposed near a midline of the package so that the thermal dissipation, temperature variation within the package and stress distribution can be optimized, the surface protection for the die can be improved and cracking defects can be reduced in Schueller's IC package.

Regarding claim 22, Schueller teaches substantially the entire claimed structure as applied to claim 20 above, wherein Schueller further teaches the silicon die being coupled/mounted to the transition medium through the adhesive (64 in Fig. 3B; Col. 9, line 65).

Regarding claim 23, Schueller teaches substantially the entire claimed structure as applied to claim 20 above, wherein Schueller further teaches the transition medium/support structure comprising a variety of material including PCB/FR-4 (Col. 10, lines 18-28), an adhesive, an elastomer, etc. (see 224 in Fig. 2 and 10 in Fig. 1; Col. 5, line 42; Col. 6, line 44; Col. 5 and 6).

Regarding claim 24, Schueller teaches substantially the entire claimed structure as applied to claim 20 above, wherein Schueller further teaches the metallized polymer layer being the tape carrier (59/60 in Fig. 3B/3A; Col. 7, lines 30-35).

6. Claims 1, 2, 4, 6-10, 12-16, 18, 19, 49-59 and 61 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schueller (US Pat. 5866949) in view of Zenner et al. (US Pat. 6246010).

Regarding claim 1, Schueller discloses an integrated circuit (IC)/BGA package comprising:

- a silicon die (52 in Fig. 3B/3A) having a first thickness

- a metallized polymer layer/flexible dielectric tape substrate (59/60 in Fig. 3B/3A; Col. 7, line 30) having a first/top side and a second/bottom side, and
- a transition medium/support structure (50 in Fig. 3B/3A) disposed between the silicon die and the first side of the metallized polymer layer where the transition medium/support structure has a second thickness

(Fig. 3B/3A; Col. 8, line 12- Col. 10, line 36; Col. 5, line 36- Col. 6, line 55).

Schueller discloses using a single transition medium/support structure having a second thickness/layer of 100-250 microns (Col. 9, line 49) or using a plurality of those layers (Col. 11, line 12) but fails to teach the first thickness of the silicon die being less than the second thickness.

Zenner et al. teach using a high density/thin package having a die thickness of about less than 100 microns or preferably less than 20 microns and a package thickness of about 275 microns (Col. 2, line 15-22; Col. 3, line 55) to reduce the total volume of the package, thermal stress, stress related failures and to improve functionality/reliability due to the thermal expansion mismatch (Col. 4, line 55- Col. 5, line 20).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to incorporate the first thickness of the silicon die with a smaller thickness than the second thickness of transition medium as taught by Zenner et al. so that the thermal stress can be reduced and the functionality/reliability of the package can be improved in Schueller's IC package.

Regarding claims 2 and 6, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 1 above, wherein Schueller further teaches the transition medium/support structure comprising a single or multilayered structure including conventional conductive/non-conductive material such as ceramic, metal, PCB or a combination of metal and non-metal/epoxy PCB material (Col. 9, line 58; Col. 10, line 27; Col. 11, line 12). Furthermore, Schueller discloses selecting the transition medium/support structure to provide various functions such as improved strength (Col. 9, line 52), thermal dissipation (Col. 9, line 10), etc. so that the thermal stress and defects such as fracture, cracking, etc. can be reduced (Col. 6-10).

Regarding claim 4, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 1 above, wherein Schueller further teaches the transition medium/support structure being made of conventional nonconductive epoxy/PCB/FR-4 type material (Col. 10, line 18-27).

Regarding claim 7, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 1 above, wherein Schueller further teaches the die being disposed approximately near the middle of a package having a thickness where the package thickness is defined by the thickness of the metallized polymer layer/tape and that of the plastic encapsulant/mold cap (Col. 8, line 40; Fig. 3B), but Schueller and Zenner et al. fail to teach the die being disposed approximately equally spaced from the bottom of the metallized polymer layer and the top of the plastic encapsulant.

The determination of parameters such as a thickness of a substrate/metallized polymer, plastic encapsulant/mold, finished package including the die, substrate and the encapsulant, thickness/area/volume ratio of various components, relative position and an arrangement of various components within the package, etc. in the chip packaging and encapsulation technology art is a subject of routine experimentation and optimization to achieve the desired thermal, dimensional/mechanical and electrical/reliability requirements including weight/size, rigidity/strength and stress distribution.

It would have been obvious to a person of ordinary skill in the art at the time invention was made to select the thickness of the encapsulant such that die is disposed approximately equally spaced from the bottom of the metallized polymer layer and the top of the plastic encapsulant as taught by Schueller and Fukutomi et al. so that the desired thermal/mechanical stress can be reduced and the and the reliability of the package can be improved in Zenner et al. and Schueller's IC package.

Regarding claims 8 and 9, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claims 1, 5 and 7 above, except the thickness of the package and die being 0.06 inches/60 mils or less and 6 mils and less respectively.

Zenner et al. further teach using the high density/thin package having the die thickness of about less than 100 microns/4 mils and a package thickness of about 275 microns/11 mils (Col. 2, line 15-22; Col. 3, line 55) to reduce the total volume of the package, thermal stress, stress related failures and to improve functionality/reliability due to the thermal expansion mismatch (Col. 4, line 55- Col. 5, line 20).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to select the thickness of the package and the die to be less than approximately 0.060 inches and 6 mils respectively as taught by Zenner et al. so that the desired thermal/mechanical stress can be reduced and the reliability of the package can be improved in Zenner et al. Schueller's IC package.

Regarding claim 10, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 1, above, wherein Schueller further teaches the die being coupled to the transition medium through an adhesive (64 in Fig. 3B; Col. 9, line 65).

Regarding claims 12 and 13, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 1, above, wherein Schueller further teaches the metallized polymer layer/flexible dielectric tape having conventional dielectric and conductive layers (60 and 59 respectively in Fig. 3B; Col. 7) and solder balls being mounted to the second side of the metallized polymer layer and electrically contacting the etched circuit in a conductive layer of the tape carrier (Fig. 3B; Col. 7, lines 32 and 58; Col. 5-12; Fig. 6).

Regarding claims 14 and 15, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claims 1, 12 and 13 above, wherein Schueller further teaches the solder balls being arranged in a grid fashion under the position for the silicon die (Fig. 3B; Col. 7, lines 32 and 58; Col. 5-12; Fig. 6) and electrically connecting the package to a PCB (Fig. 3B; Col. 7, lines 32 and 58; Col. 5-12; Fig. 6).

Regarding claim 16, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 1, above, wherein Schueller further teaches a variety of configurations (see Fig. 3A-3D, 5 and 6) where the a cross-sectional area of the die is nearly equal to or substantially less than that of the rigid transition medium (Col. 8-12).

Regarding claim 18, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 1, above, wherein Schueller teaches the package being a BGA package.

Regarding claim 19, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 1, above, but Schueller and Zenner et al. fail to teach die having a volume being less than that of the rigid transition medium.

As explained above, Schueller teaches the thickness of the transition medium being 100-250 microns (Col. 9, line 49) and the cross-sectional area of the die being less than that of the rigid transition medium (Fig. 3A-3D; Col. 8-12).

Zenner et al. teach using a high density/thin package having the die thickness of about less than 100 microns or preferably less than 20 microns (Col. 2, line 15-22; Col. 3, line 55) to reduce the total volume of the package, thermal stress, stress related failures and to improve functionality/reliability due to the thermal expansion mismatch (Col. 4, line 55- Col. 5, line 20).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to select the die having a volume being less than that of the rigid transition medium as taught by Zenner et al. so that the die support and the thermal performance can be improved in Zenner et al. and Schueller's IC package.

Regarding claim 49, Schueller discloses an integrated circuit (IC)/Ball Grid Array (BGA) package having a single or multiple IC dice (Fig. 3B; Col. 13, line 64), the package comprising:

- an IC die (52 in Fig. 3A) having a front side, backside and a first thickness between the front and back sides, where the bonding pads (Col. 8, line 25) are formed on the front side
- a metallized polymer layer/tape substrate (58/59/60 in Fig. 3A) having a first side and a second side wherein the bonding pads are electrically coupled to the features/patterns (59 in Fig. 3A) of the metallized polymer layer/tape using bonding wires (82A in Fig. 3A)
- a transition medium/support structure between the IC die and the metallized polymer layer (50A in Fig. 3A) having only an adhesive layer (64A in Fig. 3A) between the two where the transition medium/support structure has a second thickness, the second thickness being relatively uniform and none of the bonding pads being electrically coupled to the transition medium
- the backside of the IC die faces toward the transition medium and the front side of the IC die faces away from the metallized polymer layer/tape
- the IC die, metallized polymer layer/tape and transition medium are parallel planes, and
- solder balls (54 in Fig. 3A) below the metallized polymer layer/tape and the IC die electrically coupled to the bonding pads

(Fig. 3A; Col. 8, line 24; Col. 7, line 3- Col.1, line 12).

Schueller further discloses using a single transition medium/support structure having a second thickness/layer of 100-250 microns (Col. 9, line 49) or using a plurality of those layers (Col. 11, line 12) but fails to teach the second thickness being greater than the first thickness.

Zenner et al. teach using a high density/thin package having a die thickness of about less than 100 microns or preferably less than 20 microns and a package thickness of about 275 microns (Col. 2, line 15-22; Col. 3, line 55) to reduce the total volume of the package, thermal stress, stress related failures and to improve functionality/reliability due to the thermal expansion mismatch (Col. 4, line 55- Col. 5, line 20).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to incorporate the second thickness of transition medium being greater than the first thickness as taught by Zenner et al. so that the thermal stress can be reduced and the functionality/reliability of the package can be improved in Schueller's IC package.

Regarding claim 50, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 49, above, wherein Schueller teaches the front side of the die being faced away from the metallized polymer layer/tape (see Fig. 3A).

Regarding claim 51, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 49, above, wherein Schueller teaches the IC die, metallized polymer layer/tape and transition medium being three parallel planes (see Fig. 3A).

Regarding claim 52, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 49, above, wherein Schueller teaches the transition medium/support structure having a single/relatively uniform thickness (see Fig. 3A).

Regarding claim 53, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 49, above, wherein Schueller further teaches the packages being sawed/diced into a single IC die/package (Col. 13, line 64).

Regarding claims 54 and 56, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 49, above, wherein Schueller further teaches the bonding pads being electrically coupled to the features/patterns of the metallized polymer layer/tape using bonding wires (82A in Fig. 3A) and none of the bonding pads being electrically coupled to the transition medium.

Regarding claim 55, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 49, above, wherein Schueller further teaches the transition medium/support comprising a single or multilayered structure including non-polymer material, ceramic or a combination of metal and non-metal/epoxy PCB material (Col. 9, line 58; Col. 10, line 27; Col. 11, line 12).

Regarding claim 57, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 49 above, wherein Schueller further teaches having only an adhesive layer (64 in Fig. 3A) between the transition medium/support structure and IC die.

Regarding claim 58, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 49 above, wherein Schueller teaches the back side of the die facing toward the transition medium (see Fig. 3A).

Regarding claim 59, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 49 above, wherein Schueller teaches the IC package being the BGA package (see Fig. 3A).

Regarding claim 61, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 49 above, wherein Schueller further teaches the solder balls (54 in Fig. 3A) below the metallized polymer layer/tape and the IC die being electrically coupled to the bonding pads (Col. 8, line 25).

7. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Schueller (US Pat. 5866949) in view of APA.

Regarding claim 21, Schueller teaches substantially the entire claimed structure as applied to claim 20 above, except the mold cap/encapsulant having a CTE similar to that of the transition medium.

Schueller further teaches the transition medium/support structure being made of a variety of material including a PCB/FR-4 type material (Col. 10, lines 18-28).

Such conventional substrate material as PCB/package substrate, resin/FR-4 substrate, etc. have typical CTE in a range of  $12-17 \times 10^{-6}/^{\circ}\text{C}$  (see admitted prior art-Table 2).

The conventional encapsulant and molding material used in chip packaging and encapsulation technology art have thermal coefficient of expansion (CTE) range of  $7-15 \times 10^{-6}/^{\circ}\text{C}$  (see Table 2- admitted prior art).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to select the mold cap/encapsulant having a similar values of the CTE to those of the transition medium as taught by Schueller and APA so that the thermal stress can be reduced in Schueller's IC package.

8. Claims 25, 62-69 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schueller (US Pat. 5866949) in view of Zenner et al (US Pat. 6246010) and admitted prior art (APA)

Regarding claim 25, Schueller discloses an integrated circuit (IC)/BGA package comprising:

- a metallized polymer layer (MPL)/flexible dielectric tape carrier (FDTC) substrate (59/60 in Fig. 3B/3A; Col. 7, lines 30-35) having a first/top side and a second/bottom side, the MPL/FDT defining a first thickness
- a first adhesive layers (56 in Fig. 3B) having a thickness and a CTE disposed on the tape carrier (Fig. 3B; Col. 9, line 65; Col. 8, line 12- Col. 10, line 36)
- a transition medium/support structure (50 in Fig. 3B/3A) having first and second surfaces where the first surface engages the first adhesive layer and the transition medium/support structure having a thickness and a CTE

- a second adhesive layer (64 in Fig. 3B) having a thickness and a CTE disposed on the transition medium/support structure (Fig. 3B; Col. 8, line 12- Col. 10, line 36)
- a silicon die (52 in Fig. 3B/3A) having a thickness being disposed on the second adhesive layer, and
- a conventional plastic encapsulant/mold cap encapsulating the first adhesive layer, transition medium, second adhesive layer and the die (mold cap not numerically referenced- see Fig. 3B; Col. 8, line 40), wherein the mold cap and the MPL/FDTC define a package thickness, and
- the thickness of the adhesive layers, transition medium and die is approximately half the package thickness (see Fig. 3B)

(Fig. 3B/3A; Col. 8, line 12- Col. 10, line 36; Col. 5, line 36- Col. 6, line 55).

Furthermore, Schueller teaches selecting the transition medium/support having similar CTE as that of the conventional package substrate material (Col. 8, line 53) to minimize thermal stress and further teaches the transition medium/support having a thickness/layer of 100-250 microns (Col. 9, line 49) and being made of PCB/FR-4 type material (Col. 10, line 18-27).

Schueller fails to teach:

a) the thickness of the die being less than that of the transition medium and the thickness of the adhesive layers, transition medium and die is nearly equivalent to or same as the half of the package thickness

b) the transition medium and the mold cap have approximately same CTE so as to reduce the thermal stress on the die due to thermal cycling

a) Zenner et al. teach using a high density/thin package having a die thickness of about less than 100 microns or preferably less than 20 microns and a package thickness of about 275 microns (Col. 2, line 15-22; Col. 3, line 55) to reduce the total volume of the package, thermal stress, stress related failures and to improve functionality/reliability due to the thermal expansion mismatch (Col. 4, line 55- Col. 5, line 20).

Furthermore, the determination of parameters such as a thickness of a substrate/metallized polymer, plastic encapsulant/mold, finished package including the die, substrate and the encapsulant, thickness/area/volume ratio of various components, relative position and an arrangement of various components within the package, etc. in the chip packaging and encapsulation technology art is a subject of routine experimentation and optimization to achieve the desired thermal, dimensional/mechanical and electrical/reliability requirements including weight/size, rigidity/strength and stress distribution.

b) APA teaches the conventional substrate material as PCB, FR-4/package substrate resin, etc. have typical CTE in the range of  $12-17 \times 10^{-6}/^{\circ}\text{C}$  (see admitted prior art-Table 2).

APA further teaches the mold cap having a CTE of about  $7-15 \times 10^{-6}/^{\circ}\text{C}$  (see admitted prior art-Table 2), the values within the range being approximately the same for the transition medium/support structure and the mold cap.

It would have been obvious to a person of ordinary skill in the art at the time invention was made to select the thickness of the die being less than that of the transition medium, the thickness of the adhesive layers, transition medium and die is nearly equivalent to or same as the half of the package thickness and the transition medium and the mold cap having approximately the same CTE so as to reduce the thermal stress on the die due to thermal cycling or temperature extremes as taught by Zenner et al. and APA in Schueller's IC package.

Regarding claim 62, Schueller discloses an integrated circuit (IC)/BGA package comprising:

- a silicon die (52 in Fig. 3B/3A) having a first thickness
- a substrate comprising a metallized polymer layer/tape (59/60 in Fig. 3B/3A; Col. 7, line 30) having a first/top side and a second/bottom side, and
- a transition medium/support structure (50 in Fig. 3B/3A) disposed between the silicon die and the substrate, the transition medium/support structure having a second thickness, and
- a conventional plastic encapsulant/mold cap encapsulating the die and the transition medium (mold cap not numerically referenced- see Fig. 3B; Col. 8, line 40),

(Fig. 3B/3A; Col. 8, line 12- Col. 10, line 36; Col. 5, line 36- Col. 6, line 55).

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Furthermore, Schueller teaches selecting the transition medium/support having similar CTE as that of the conventional package substrate material (Col. 8, line 53) to minimize thermal stress and further teaches the transition medium/support having a thickness/layer of 100-250 microns (Col. 9, line 49) and being made of PCB/FR-4 type material (Col. 10, line 18-27).

Schueller fails to teach:

- a) the thickness of the transition medium being greater than that of the die, and
- b) the transition medium and the plastic encapsulant having approximately equal CTE.

a) Zenner et al. teach using a high density/thin package having a die thickness of about less than 100 microns or preferably less than 20 microns and a package thickness of about 275 microns (Col. 2, line 15-22; Col. 3, line 55) to reduce the total volume of the package, thermal stress, stress related failures and to improve functionality/reliability due to the thermal expansion mismatch (Col. 4, line 55- Col. 5, line 20).

b) APA teaches the conventional substrate material as PCB, FR-4/package substrate resin, etc. have typical CTE in the range of  $12-17 \times 10^{-6}/^{\circ}\text{C}$  (see admitted prior art-Table 2).

APA further teaches the mold cap having a CTE of about  $7-15 \times 10^{-6}/^{\circ}\text{C}$  (see admitted prior art-Table 2), the values within the range being approximately the same for the transition medium/support structure and the mold cap.

It would have been obvious to a person of ordinary skill in the art at the time invention was made to select the thickness of the transition medium being greater than

that of the die and the transition medium and the plastic encapsulant having approximately equal as taught by Zenner et al. and APA so that the thermal stress can be reduced and the functionality/reliability of the package can be improved in Schueller's IC package.

Regarding claim 63, Schueller, Zenner et al. and APA teach substantially the entire claimed structure as applied to claim 62 above, wherein Schueller further teaches the transition medium comprising a first adhesive layer (56 in Fig. 3B) disposed between the transition medium and the substrate and a second adhesive layer (64 in Fig. 3B) disposed between the transition medium and the die (Fig. 3B; Col. 9, line 65; Col. 8, line 12- Col. 10, line 36).

Regarding claim 64, Schueller, Zenner et al. and APA teach substantially the entire claimed structure as applied to claim 62 above, wherein Schueller further teaches the distance from the top of the plastic encapsulant/mold cap being the package thickness, wherein the die is positioned approximately in the middle of the package thickness (see Fig. 3B).

The determination of parameters such as a thickness of a substrate/metallized polymer, plastic encapsulant/mold, finished package including the die, substrate and the encapsulant, thickness/area/volume ratio of various components, relative position and an arrangement of various components within the package, etc. in the chip packaging and encapsulation technology art is a subject of routine experimentation and optimization to achieve the desired thermal, dimensional/mechanical and

electrical/reliability requirements including weight/size, rigidity/strength and stress distribution.

Regarding claim 65, Schueller, Zenner et al. and APA teach substantially the entire claimed structure as applied to claim 62 above, wherein Schueller further teaches the transition medium/support structure being made of conventional nonconductive epoxy/PCB/FR-4 type material (Col. 10, line 18-27).

Regarding claim 66, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 1 above, except the range of CTE for the transition medium being between  $7 \times 10^{-6}/^{\circ}\text{C}$  and  $17 \times 10^{-6}/^{\circ}\text{C}$ .

Schueller further teaches the transition medium/support structure being made of PCB/FR-4 type material (Col. 10, line 18-27).

APA teaches the conventional material/substrates as PCB/plastic, FR-4/package substrate, etc. have typical CTE in the range of  $12\text{-}17 \times 10^{-6}/^{\circ}\text{C}$  (see admitted prior art-Table 2).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to select the transition medium having the CTE of the transition medium being between  $7 \times 10^{-6}/^{\circ}\text{C}$  and  $17 \times 10^{-6}/^{\circ}\text{C}$  as taught by Schueller and APA so that the thermal stress can be reduced in Zenner et al. and Schueller's IC package.

Regarding claim 67, Schueller discloses an integrated circuit (IC)/BGA package comprising:

- a silicon die (52 in Fig. 3B/3A) having a first thickness
- a metallized polymer layer (MPL)/tape substrate (59/60 in Fig. 3B/3A; Col. 7, line 30) having a first/top side and a second/bottom side, and
- a transition medium/support structure (50 in Fig. 3B/3A) disposed between the silicon die and the MPL, the transition medium/support structure having a second thickness, and
- a conventional plastic encapsulant/mold cap encapsulating the die and the transition medium (mold cap not numerically referenced- see Fig. 3B; Col. 8, line 40),

(Fig. 3B/3A; Col. 8, line 12- Col. 10, line 36; Col. 5, line 36- Col. 6, line 55).

Furthermore, Schueller teaches selecting the transition medium/support having similar CTE as that of the conventional package substrate material (Col. 8, line 53) to minimize thermal stress and further teaches the transition medium/support having a thickness/layer of 100-250 microns (Col. 9, line 49) and being made of PCB/FR-4 type material (Col. 10, line 18-27).

Schueller fails to teach:

- a) the first thickness of the die being less than the second thickness, and
- b) the transition medium and the plastic encapsulant having approximately equal CTE.

a) Zenner et al. teach using a high density/thin package having a die thickness of about less than 100 microns or preferably less than 20 microns and a package thickness of about 275 microns (Col. 2, line 15-22; Col. 3, line 55) to reduce the total volume of the package, thermal stress, stress related failures and to improve functionality/reliability due to the thermal expansion mismatch (Col. 4, line 55- Col. 5, line 20).

b) APA teaches the conventional substrate material as PCB, FR-4/package substrate resin, etc. have typical CTE in the range of  $12-17 \times 10^{-6}/^{\circ}\text{C}$  (see admitted prior art-Table 2).

APA further teaches the mold cap having a CTE of about  $7-15 \times 10^{-6}/^{\circ}\text{C}$  (see admitted prior art-Table 2), the values within the range being approximately the same for the transition medium/support structure and the mold cap.

It would have been obvious to a person of ordinary skill in the art at the time invention was made to select the first thickness of the die being less than the second thickness and the plastic encapsulant having approximately equal as taught by Zenner et al. and APA so that the thermal stress can be reduced and the functionality/reliability of the package can be improved in Schueller's IC package.

Regarding claim 68, Schueller, Zenner et al. and APA teach substantially the entire claimed structure as applied to claim 67 above, except the CTE of the transition medium being greater than that of the silicon die and less than that of the plastic encapsulant.

APA further teaches the ranges of the package substrate/transition medium being  $12-17 \times 10^{-6}/^{\circ}\text{C}$ , the mold cap/encapsulant being  $7-15 \times 10^{-6}/^{\circ}\text{C}$  and silicon die being  $2.6-6.0 \times 10^{-6}/^{\circ}\text{C}$  (see admitted prior art-Table 2), such that one or more values from these ranges can be selected to satisfy the requirement for the transition medium having the CTE being greater than that of the silicon die and less than that of the plastic encapsulant.

Furthermore, the determination of parameters such as a thickness of a substrate/metallized polymer, plastic encapsulant/mold, finished package including the die, substrate and the encapsulant, thickness/area/volume ratio and CTE/composition of various components in the chip packaging and encapsulation technology art is a subject of routine experimentation and optimization to achieve the desired thermal, dimensional/mechanical and electrical/reliability requirements including weight/size, rigidity/strength and stress reduction due to thermal mismatch.

It would have been obvious to a person of ordinary skill in the art at the time invention was made to select the transition medium being greater than that of the silicon die and less than that of the plastic encapsulant as taught by Schueller and APA so that the thermal stress can be reduced and the functionality/reliability of the package can be improved in Zenner et al., APA and Schueller's IC package.

Regarding claim 69, Schueller discloses an integrated circuit (IC)/BGA package comprising:

- a silicon die (52 in Fig. 3B/3A) having a first thickness
- a metallized polymer layer (MPL)/tape substrate (59/60 in Fig. 3B/3A; Col. 7, line 30) having a first/top side and a second/bottom side, and

- a transition medium/support structure (50 in Fig. 3B/3A) disposed between the silicon die and the MPL, the transition medium/support structure having a second thickness, and
- the package having external connections/solder balls (54 in Fig. 3B) and being capable of being mounted to a printed circuit board (PCB)

(Fig. 3B/3A; Col. 8, line 12- Col. 10, line 36; Col. 5, line 36- Col. 6, line 55).

Furthermore, Schueller teaches selecting the transition medium/support having similar CTE as that of the conventional package substrate material (Col. 8, line 53) to minimize thermal stress and further teaches the transition medium/support having a thickness/layer of 100-250 microns (Col. 9, line 49) and being made of PCB/FR-4 type material (Col. 10, line 18-27).

Schueller fails to teach:

- a) the first thickness of the die being less than the second thickness, and
- b) the transition medium having a CTE being less than the PCB and being greater than that of the silicon die.

a) Zenner et al. teach using a high density/thin package having a die thickness of about less than 100 microns or preferably less than 20 microns and a package thickness of about 275 microns (Col. 2, line 15-22; Col. 3, line 55) to reduce the total volume of the package, thermal stress, stress related failures and to improve functionality/reliability due to the thermal expansion mismatch (Col. 4, line 55- Col. 5, line 20).

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b) APA further teaches the ranges of the package substrate/transition medium being  $12-17 \times 10^{-6}/^{\circ}\text{C}$ , the PCB being  $17 \times 10^{-6}/^{\circ}\text{C}$  and silicon die being  $2.6-6.0 \times 10^{-6}/^{\circ}\text{C}$  (see admitted prior art-Table 2), such that one or more values from these ranges can be selected to satisfy the requirement for the transition medium having the CTE being greater than that of the silicon die and less than that of the PCB.

Furthermore, the determination of parameters such as a thickness of a substrate/metallized polymer, plastic encapsulant/mold, finished package including the die, substrate and the encapsulant, thickness/area/volume ratio and CTE/composition of various components in the chip packaging and encapsulation technology art is a subject of routine experimentation and optimization to achieve the desired thermal, dimensional/mechanical and electrical/reliability requirements including weight/size, rigidity/strength and stress reduction due to thermal mismatch.

It would have been obvious to a person of ordinary skill in the art at the time invention was made to select the first thickness of the die being less than the second thickness, and the transition medium having a CTE being less than the PCB and being greater than that of the silicon die as taught by Schueller and APA so that the thermal stress can be reduced and the functionality/reliability of the package can be improved in Zenner et al., APA and Schueller's IC package.

9. Claims 3, 5, 11, 60 and 70 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schueller (US Pat. 5866949) and Zenner et al (US Pat. 6246010) as applied to claims 1, 10 and 49 above, and further in view of admitted prior art (APA).

Regarding claims 3 and 11, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 1 above, Schueller further discloses encapsulating the silicon die and the transition medium with a conventional plastic encapsulant/mold cap, but Schueller and Zenner et al. fail to teach the encapsulant and adhesive having a thermal coefficient of expansion (CTE) approximately in a range of  $7-15 \times 10^{-6}/^{\circ}\text{C}$  and  $58 \times 10^{-6}/^{\circ}\text{C}$  respectively.

The conventional encapsulant/mold cap and adhesives used in chip packaging and encapsulation technology art have thermal coefficient of expansion (CTE) range of  $7-15 \times 10^{-6}/^{\circ}\text{C}$  and approximately  $58 \times 10^{-6}/^{\circ}\text{C}$  respectively (Table 2- admitted prior art).

Furthermore, the determination of parameters such as a thickness of a substrate/metallized polymer, plastic encapsulant/mold, finished package including the die, substrate and the encapsulant, thickness/area/volume ratio of various components, relative position and an arrangement of various components within the package, etc. in the chip packaging and encapsulation technology art is a subject of routine experimentation and optimization to achieve the desired thermal, dimensional/mechanical and electrical/reliability requirements including weight/size, rigidity/strength and stress distribution.

It would have been obvious to a person of ordinary skill in the art at the time invention was made to incorporate a plastic encapsulant and adhesive having approximate CTE range of  $7-15 \times 10^{-6}/^{\circ}\text{C}$  and  $58 \times 10^{-6}/^{\circ}\text{C}$  respectively as taught by APA so that the thermal stress can be reduced in Zenner et al. and Schueller's package.

Regarding claims 5, 60 and 70, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claims 1, 3 and 49 above, except the range of CTE for the transition medium being between  $7 \times 10^{-6}/^{\circ}\text{C}$  and  $17 \times 10^{-6}/^{\circ}\text{C}$  or the CTE of the transition medium and the plastic encapsulant being approximately equal respectively.

Schueller further teaches the transition medium/support structure being made of PCB/FR-4 type material (Col. 10, line 18-27).

APA teaches the conventional substrate material such as a PCB/package substrate, FR-4/resin substrate, etc. having typical CTE in the range of  $12-17 \times 10^{-6}/^{\circ}\text{C}$  and the encapsulant/mold cap having the CTE range of  $7-15 \times 10^{-6}/^{\circ}\text{C}$  (see admitted prior art-Table 2).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to select the transition medium having the CTE of the transition medium being between  $7 \times 10^{-6}/^{\circ}\text{C}$  and  $17 \times 10^{-6}/^{\circ}\text{C}$  or the CTE of the transition medium and the plastic encapsulant being approximately equal as taught by Schueller and APA so that the thermal stress can be reduced in Zenner et al. and Schueller's IC package.

Regarding claim 60, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 1 above, except the range of CTE for the transition medium being between  $7 \times 10^{-6}/^{\circ}\text{C}$  and  $17 \times 10^{-6}/^{\circ}\text{C}$ .

Schueller further teaches the transition medium/support structure being made of PCB/FR-4 type material and further discloses conventional BGA packages having an adhesive and an elastomer being used as a transition medium (224 in Fig. 2 and 10 in

Fig. 1 respectively; Col. 5 and 6). Such conventional material/substrates as epoxy, molded plastic, FR-4/5, BT resin, etc. have typical CTE in the range of  $12-17 \times 10^{-6}/^{\circ}\text{C}$  (see admitted prior art-Table 2).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to select the transition medium having the CTE of the transition medium being between  $7 \times 10^{-6}/^{\circ}\text{C}$  and  $17 \times 10^{-6}/^{\circ}\text{C}$  as taught by Schueller and APA so that the thermal stress can be reduced in Zenner et al. and Schueller's IC package.

10. Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over Schueller (US Pat. 5866949) and Zenner et al (US Pat. 6246010) as applied to claim 1 above, and further in view of Fukutomi et al. (US Pat. 5976912).

Regarding claim 17, Schueller and Zenner et al. teach substantially the entire claimed structure as applied to claim 1, above, except the die having a cross-sectional area being larger than that of the transition medium.

Fukutomi et al. teach a variety of an encapsulated IC package configurations comprising a metallized polymer/polyimide substrate and a die (see 29 and 3 respectively in Fig. 16f) where the die has a dimension/cross-sectional area being larger than that of a support/transition medium (4' in Fig. 16a-16f; Fig. 14, Fig. 23; Col. 15, line 35- Col. 16, line 13).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to select the die having a cross-sectional area being larger than that of the transition medium as taught by Fukutomi et al. so that the weight of the package can be reduced in Zenner et al. Schueller's IC package.

***Response to Arguments***

11. Applicant's arguments filed on 09-29-03 have been fully considered but they are not persuasive.

A. Applicant contends that Zenner et al. teach away from using the package having solder balls greater than 100 microns, which is the size, used in Schueller's package.

However, Zenner et al. refers to solder ball dimensions (100 microns) for the flip chip configuration as the chip bonding method. The solder balls having greater than 100 microns dimension is being referenced to the external solder balls (54 in Fig. 3B) in Schueller's package, and not the solder balls of the flip chip.

B. Applicant contends that Schueller focuses on the rigid package while Zenner et al. focus on the flexible package.

However, Schueller teaches the BGA package having the flexible/tape substrate comprising the transition medium/support structure having suitable/sufficient rigidity to allow the processing in the strip format, the transition medium/support structure having the layer, which is thinner and less rigid than a support structure (Col. 3, lines 55-60). Furthermore, Schueller teaches the transition medium/support structure having a low rigidity or modulus less than  $6.89 \times 10^6$ , if desired (Col. 9, lines 60-64), and further being capable of being processed/packaged in a roll of the layer instead of a strip (Col. 12, line 33-35).

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nitin Parekh whose telephone number is 703-305-3410. The examiner can normally be reached on 09:00AM-05:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie Lee can be reached on 703-305-1690. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9318.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956

NP

11-14-03



NITIN PAREKH

PATENT EXAMINER

TECHNOLOGY CENTER 2800